

Title: CONGENITAL HEART MALFORMATIONS AND UPTAKE OF ISOFLURANE
Authors: S. G. E. Lindahl, M.D., Ph.D., R. A. Van Dyke, Ph.D., M. D. Abel, M.D., and H. S. Raimundo, M.D.
Affiliation: Department of Anesthesiology, Mayo Clinic, Rochester, MN 55905

Introduction. Uptake of volatile anesthetic agents is a complex and multifaceted phenomenon already in the child with normal cardiopulmonary function. In children with congenital heart malformation, there is a spectrum of lung perfusion ranging from pulmonary oligemia to pulmonary plethora which makes the uptake of volatile anesthetic agents unpredictable. The object of this study was to identify whether children with acyanotic and cyanotic congenital heart malformations had different uptake characteristics for isoflurane as measured by end-tidal and arterial concentrations.

Methods. With the approval of the Institutional Review Board and after obtaining parental consent, 20 children between 11 days and 12 years of age were studied. Children whose chest roentgenogram was normal or showed signs of increased lung perfusion and who had a hematocrit of less than 44% were considered to be acyanotic. Those with radiologic signs of oligemic lungs and who had hematocrit greater than 44% were placed in a cyanotic group. Ten children were acyanotic and had an age range between 11 days and 9 years with body weights ranging from 4.5 to 33 kg (ASA status II - III). Another 10 patients fulfilled criteria for the cyanotic group; they ranged in ages from 8 months to 12 years with body weights from 7.1 to 27.5 kg (ASA status III). In three patients of each group, preoperative ratios between pulmonary and systemic blood flow were calculated. The intravenous anesthetic protocol was identical for both cyanotic and acyanotic groups. The trachea was intubated with a cuffed endotracheal tube (Mallinkrodt), and the child was ventilated with oxygen in air (FI_{O_2} 0.5) using a Servo-ventilator. The ventilation was adjusted in order to achieve an arterial CO_2 tension of about 30 mmHg. Once the CO_2 tension had stabilized, an additional 20 to 30 minutes of mechanical ventilation using the same setting was employed prior to adding an inspired isoflurane concentration of $0.70 \pm 0.01\%$ (mean \pm SD). A calibrated mass spectrometer (Perkin-Elmer, Medical Gas Analyzer, MGA 1103, sampling rate 240 ml/min) was used. Gas was sampled from the tip of the tracheal tube. Serial arterial samples were withdrawn for analysis of isoflurane by a gas chromatograph. Comparisons of results were carried out with unpaired Student's t-tests and probability values below 0.05 were considered to indicate statistical significance.

Results. Arterial carbon dioxide tensions were kept constant during the study. The ratios between end-tidal and inspired isoflurane concentrations were similar in acyanotic and cyanotic children (Fig. 1). There were no differences in mean values of arterial isoflurane concentration between cyanotic and acyanotic children (Fig. 2). Preoperative ratios between pulmonary and systemic circulation (\dot{Q}_p/\dot{Q}_s) of 0.78, 0.89 and 0.73 in cyanotic and

4.73, 4.23 and 2.6 in acyanotic showed no relationship with arterial isoflurane uptake kinetics.

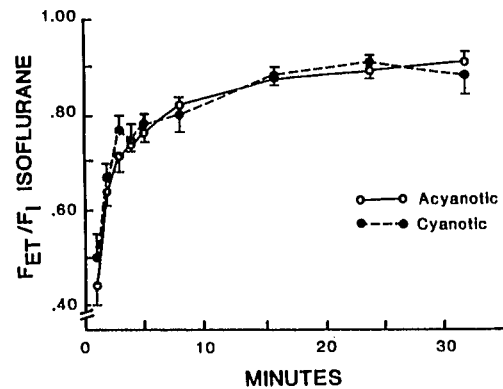


Fig. 1: End-tidal to inspired isoflurane fractions (F_{ET}/F_I , mean values \pm SEM).

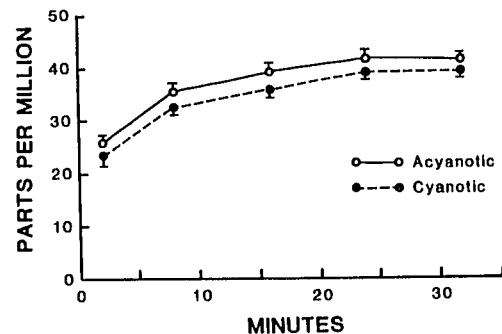


Fig. 2: Arterial isoflurane concentrations in parts per million related to the duration of isoflurane inhalation in minutes (mean values \pm SEM).

Discussion. Our results contradict Stoelting and Longnecker's measurements of halothane uptake in arterial blood in 3 children before and after total correction of tetralogy of Fallot.¹ Their patients had, however, Q_p/Q_s ratios around 0.35 as opposed to Q_p/Q_s ratios of 0.70 or higher in this study, indicating the importance of lung perfusion for the uptake of inhalational anesthetics. In summary, children with congenital heart malformations resulting in cyanosis (Q_p/Q_s lower than 1.0 but higher than 0.70) had uptake kinetics for isoflurane that were similar to in acyanotic children.

References.

1. Stoelting RK, Longnecker DE: The effect of right-to-left shunt on the rate of increase of arterial anesthetic concentration. *Anesthesiology* 36:352-356, 1972